PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : B05D 3/06, D21G 3/00, F16C 13/00, D21G 1/00, C09D 4/00, D21F 3/08

A1

(11) International Publication Number: WO 00/48747

(43) International Publication Date: 24 August 2000 (24.08.00)

(21) International Application Number: PCT/FI00/00110

(22) International Filing Date: 15 February 2000 (15.02.00)

(30) Priority Data:
990299 15 February 1999 (15.02.99) FI

(71) Applicant *(for all designated States except US)*: VALMET CORPORATION [FI/FI]; Fabianinkatu 9 A, FIN–00130 Helsinki (FI).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: SORSA, Petri [FI/FI]; Kohmankaari 14 E 69, FIN–33310 Tampere (FI). KNUUTTILA, Jari [FI/FI]; Satamakatu 1 A 20, FIN–33200 Tampere (FI). VESTOLA, Juhani [FI/FI]; Tähtäin 25, FIN–40630 Jyväskylä (FI). NIEMI, Kari [FI/FI]; Lennostontie 4 I 16, FIN–41160 Tikkakoski (FI).

(74) Agent: FORSSÉN & SALOMAA OY; Yrjönkatu 30, FIN–00100 Helsinki (FI).

(81) Designated States: AE, AL, AM, AT, AT (Utility model), AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, CZ (Utility model), DE, DE (Utility model), DK, DK (Utility model), DM, EE, EE (Utility model), ES, FI, FI (Utility model), GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (Utility model), SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.
In English translation (filed in Finnish).

(54) Title: METHOD FOR SEALING OF A WEARING FACE

(57) Abstract

The invention relates to a method for repairing local damage and/or for sealing the porosity of wearing surfaces expected to exhibit a good wear resistance in a pulp, paper, board or finishing machine, said surfaces being in contact with a paper web or pulp or a moving fabric. The invention also concerns a coated component for a pulp, paper or board machine or a finisching machine, said component being in contact with a paper web or pulp during the process. According to the method, said surface is coated with a sealing agent containing a synthetic polymer which is curable by means of electromagnetic radiation, whereupon the polymer is cured with the help of a source of radiation.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece			TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	NZ	New Zealand		
CM	Cameroon			PL	Poland		
CN	China	KR	Republic of Korea	PT	Portugal		
CU	Cuba	KZ	Kazakstan	RO	Romania		
CZ	Czech Republic	LC	Saint Lucia	RU	Russian Federation		
DE	Germany	LI	Liechtenstein	SD	Sudan		
DK	Denmark	LK	Sri Lanka	SE	Sweden		
EE	Estonia	LR	Liberia	SG	Singapore		

Method for sealing of a wearing face

The invention relates to a method for sealing a wearing surface in a pulp/paper/board/finishing machine and/or for repairing damage in such a surface, as well as to the use of a UV curable sealing agent for sealing and/or for repairing wearing surfaces and, further, to articles manufactured by way of the method. Specific applications of the method are rolls surfaced with a ceramic/cermet or polymer coating. Further objects of the invention relate to ceram coated dewatering blades and doctor blades, among others.

In a paper and board machine, rolls with ceramic and cermet coatings have by large replaced granite rolls used earlier in the art. With a roll with a ceramic or cermet coating, corrosion of various degrees occurs, particularly under harsh conditions causing corroding of the roll, delamination of the coating and thus the roll gradually wears unusable, further occurs mechanical wear and damage due to different reasons. A roll coating made by way of thermal spraying unavoidably always remains somewhat porous, thus allowing moisture penetration through the porous surface toward the inner metallic layers of the roll thus causing corrosion. Process conditions in the paper and board industry have continually become more and more severe and demanding on the equipment, among other reasons, due to the trend toward enhanced circulation of process water for environmental protection and change of process environment in a more corrosive direction.

Various methods have been attempted to improve the corrosion resistance of rolls. As examples of these, reference can be made to *FI Patent Nos. 86,566, 82,094* and *84,506* teaching the improvement of corrosion resistance in rolls by way of adding metal or cermet layers between the ceramic/cermet roll surface coating and the roll mantle. From *FI Patent Application No. 971,541* is known the application of an impervious intermediary layer deposited by high-speed flame spraying under a

porous ceramic surface coating. Attempts have also been made to seal the outer surface of ceramic coatings. In *WO publication No. 97/15719*, a technique is disclosed for sealing a ceramic coating by means of an inorganic solution, in which technique, in order to reduce the porosity of the ceramic layer, an inorganic compound is applied to the surface of the roll after surfacing the same. In *EP Patent Application No. 0,481,321*, a roll for a paper machine is described having a synthetic resin or wax applied to the ceramic coating in order to seal its pores, wherein conventional heat-curable epoxy resins are mentioned as suitable synthetic resins. Damage caused by mechanical stresses and wear are repaired most typically with the help of a heat-curable epoxy resin, whereby the paper machine must be shut down for at least 1 to 3 days in order to allow the repaired or sealed area dry sufficiently. Attempts have been made to speed up the curing process by infrared radiation, but nevertheless the method still is slow. It is obvious from the above-discussed background that there is an imminent need for finding a quick and easy-to-use technique for sealing the surfaces of rolls used in a paper and board machine and for repairing damage and wear occurring in the same.

The object of the present invention is to provide a method for sealing surfaces subject to wear, particularly those of a roll in a paper or board machine such as a press roll or calender roll or ceramic-surfaced dewatering blades, and for repairing surface damage in the same and, further, to disclose the use of a UV curable sealing agent in the sealing and repair of surfaces subject to wear, particularly those of a roll in a paper or board machine, and components made by virtue of said method for a paper machine.

The method, use and components according to the invention are characterized by what is stated in the claims.

The shortcomings of conventional methods known in the art for sealing and repairing of surface coatings in paper or board machines can be avoided or decisively reduced by virtue of the method described in the following. It has now been found that sealing and repair of rolls can be made faster and easier than in the prior art by means

of using a sealing and repair agent that is curable by electromagnetic radiation. In the method according to the invention, wearing surfaces that are in contact with a paper web and/or pulp and/or a moving fabric are treated by applying on the surface to be treated a synthetic polymer compound curable by electromagnetic radiation, advantageously UV radiation.

Suitable synthetic polymer resins curable by radiation are epoxy acrylates, polyester acrylates, urethane acrylates, silicone acrylates, polyether acrylates and acrylate esters and mixtures thereof having a reactive thinner, a photoinitiator and a secondary curing catalyst added thereto. Advantageous polymer resins curable by radiation are urethane acrylates and acrylate esters. When a polymer resin such as urethane acrylate is cured using UV light, an exothermic reaction is triggered in which the primary curing is launched by the UV light but the hardening process is continued as a secondary, heat-supported curing reaction taking place via a catalytic or anaerobic curing mechanism that secures curing deeper at the bottom of the pores. Polymers suitable for use as sealing compounds are characterized by both a primary UV-catalyzed curing mechanism and a secondary heat-supported catalytic curing mechanism or, alternatively, an anaerobic curing mechanism that needs the absence of oxygen. An organic polymer resin may also be blended with thixotropic agents and fillers. Suitable thixotropic agents are hydrophobic or hydrophilic compounds such as silicon dioxide, whereby the particle size of the thixotropic agent is advantageously in the range of 10 – 2000 nm. Suitable filler materials are silicon dioxide, ceramic fillers such as aluminium oxide and chromium oxide, metals, polymeric filler particles and fibers. The filler is advantageously in the form of a pulverized or microspherical or fibrous material and, advantageously, composed of the same material as that used in the original coating of the surface to be sealed or repaired. The particle size of the filler material is advantageously in the range of 2 – 45 μm. Sealing a surface does not necessarily require the use of a filler or thixotropic agent. The repair of worn or damaged areas is advantageously made using a composition comprising not more than 75 vol.-% of a filler, not more than 10 vol.-% and, advantageously, 1 – 5 % of a thixotropic agent such as silicon dioxide, and not less than 15 vol.-% and advantageously 50 – 95 vol-% of an organic

polymer such as urethane acrylate or acrylate ester.

The sealing or repair agent is applied to the desired surface area by spreading, dipping, spraying or using some other mechanical means depending on the point of use. When the surface of a roll is being sealed, the filler may also be applied to the roll surface separately after the radiation-curable organic polymer is first applied thereto, whereby the filler covering the roll surface can improve the wear resistance of the surface. The sealing or repair agent is cured on a porous coating by means of electromagnetic radiation, advantageously using UV light emitted by conventional UV lamps at a suitable wavelength, whereby the radiation intensity maxima advantageously fall at wavelength bands about 270 nm and 365 nm. The maxima of radiation intensity needed are determined by the type of photoinitiator used. The electromagnetic radiation is imposed at an intensity of 1 W/cm^2 – 100,000 W/cm^2 and the power output of the UV lamp is advantageously in the range of 1 – 10,000 W/cm^2. The radiation is allowed to irradiate the desired surface from 0.1 s to 10 h when the surface is to be repaired or sealed. Typically, the curing time is less than one hour and most typically 5 to 10 minutes. Curing can be carried out either by irradiating the surface only once after the entire amount of the sealing or repair agent has been applied or, alternatively, by alternate steps of applying a layer of the sealing or repair agent at the desired area, curing the same and then applying a new layer and curing the same again.

If the surface to be treated is pure from metal ions, it is advantageous to pretreat the surface with a solution containing metal ions, advantageously using copper chloride solution in which the copper chloride is dissolved in an organic solvent such as hexane, whereby the applied copper ions act as activator. The use of an activator is particularly advantageous in the case that the application area is totally free from metal ions or the compound contains a lot of filler that hinders the penetration of UV light through the material.

The sealing and repair method according to the invention can be exploited in paper and board machines on their rolls, dewatering blades, doctor blades, ceram-coated

blades and, generally, on wear-resistant surfaces coming into contact with a paper web or pulp. Advantageously, the invention is used on rolls having a ceramic or cermet coating. The invention is also applicable to polymer-coated rolls, especially for repairing local damages of their outer coverings. The technique according to the invention can be utilized for improving the corrosion resistance of the combination of a surface coating and underlayer and the mechanical qualities of the coating. As compared to heat-catalyzed sealing materials such as conventional epoxy sealant systems, the UV-curable sealing agent excels particularly by its low curing temperature, fast curing to a high degree of cross-linking, low exothermic heat release during curing, small curing shrinkage, low viscosity at room temperature, low surface tension and low partial vapour pressure at room temperature.

By virtue of the method according to the invention, it is possible to produce quickly on a desired surface, such as that of a roll, a protective surface layer of good corrosion resistance and to seal the pores of a surface, especially those of a ceramic surface, in an efficient way. Simultaneously, it is possible to affect the surface qualities of a roll by way of selecting a suitable polymer and, optionally, a suitable filler.

In conjunction with rolls and dewatering blades, a particular benefit is that entire workpiece need not be taken to an elevated temperature, which generally is awkward to arrange and costly.

In repair operations, the speed of the method is a particular advantage, because the repair can be carried out rapidly and without dismounting a roll from the machine, thus achieving significant savings through lower shutdown costs.

Claims

1. Method for repairing local damage and/or for sealing the porosity of wearing surfaces requiring a good wearability in a pulp, paper, board or finishing machine, said surfaces being in contact with a paper web or pulp or a moving fabric, **characterized** in that said surface is coated with a sealing agent containing a synthetic polymer which is curable by means of electromagnetic radiation, whereupon the polymer is cured with the help of a source of radiation.

2. Method according to claim 1, **characterized** in that the synthetic polymer comprises epoxy acrylates, polyester acrylates, urethane acrylates, silicone acrylates, polyether acrylates and acrylate esters and mixtures thereof.

3. Method according to claim 1 or 2, **characterized** in that a reactive thinner, a photoinitiator and a secondary curing catalyst are added into said synthetic polymer.

4. Method according to any one of claims 1 – 3, **characterized** in that said synthetic polymer is blended with a filler material, advantageously silicon dioxide, a ceramic, metallic or polymeric filler material and/or fiber, wherein the particle size of the filler material is in the range of 2 – 45 μm.

5. Method according to any one of claims 1 – 4, **characterized** in that said polymer is blended with a hydrophobic or hydrophilic thixotropic agent having the particle size in the range of 10 – 2000 nm.

6. Method according to any one of claims 1 – 5, **characterized** in that said sealing agent contains synthetic polymer not less than 15 vol.-%, filler material not more than 75 vol.-% and thixotropic agent not more than 10 vol.-%.

7. Method according to any one of claims 1 – 6, **characterized** in that said sealing agent is cured with the help of electromagnetic radiation applied at an intensity in the range of 1 W/cm^2 – 100,000 W/cm^2.

8. Method according to any one of claims 1 – 7, **characterized** in that said electromagnetic radiation is UV light with the radiation intensity maxima falling at wavelength bands 270 nm and 365 nm and the power output of the UV lamp being in the range of 1 – 10,000 W/cm^2.

9. Use of a sealing agent curable with the help of electromagnetic radiation for repairing local damage and/or for sealing the porosity of wear-resistant surfaces in a pulp, paper, board or finishing machine, said surfaces being in contact with a paper web or pulp, **characterized** in that said sealing agent contains a synthetic polymer, advantageously epoxy acrylates, polyester acrylates, urethane acrylates, silicone acrylates, polyether acrylates and acrylate ester, whereby the base polymers have a reactive thinner, a photoinitiator and a secondary curing catalyst added thereto.

10. Use according to claim 9, **characterized** in that said sealing agent additionally contains a hydrophobic or hydrophilic thixotropic agent having the particle size in the range of 10 – 2000 nm.

11. Use according to claim 9 or 10, **characterized** in that said synthetic polymer is blended with a filler material, advantageously silicon dioxide, ceramic, metallic or polymeric filler materials or fiber having the particle size in the range of 2 – 45 μm.

12. Coated component for a cellulosic paper or board or finishing machine, said component being in contact with a paper web or pulp during the process, **characterized** in that said component is a roll with a ceramic or cermet coating having its coating sealed using any one of the methods of claims 1 - 8.

13. Component according to claim 12, **characterized** in that said component is a roll with a ceramic or cermet or polymeric coating whose surface damage has been repaired using any one of the methods of claims 1 - 8.

14. Component according to claim 12, **characterized** in that said component is a

dewatering blade with a ceramic or cermet surface coating.

15. Component according to claim 12, **characterized** in that said component is a doctor blade with a ceramic or cermet surface coating.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 00/00110

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B05D 3/06, D21G 3/00, F16C 13/00, D21G 1/00, C09D 4/00, D21F 3/08
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B05D, D21G, D21F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0257812 A2 (THE STANDARD OIL COMPANY), 2 March 1988 (02.03.88), page 2, line 1 - line 5; page 4, line 14 - line 18; page 6, line 41 - line 50, abstract --	1-15
X	US 5851598 A (JAMES O. GALLANT), 22 December 1998 (22.12.98), column 1, line 13 - line 23; column 1, line 34 - line 39; column 1, line 59 - line 65, column 2, line 62 - line 64; column 3, line 56 - line 67; figures 8-11; abstract --	1-15

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 June 2000	05 -07- 2000
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Helena Hemphälä Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 00/00110

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4728530 A (HARTMUT WALDVOGEL ET AL), 1 March 1988 (01.03.88), column 4, line 7 - line 11; column 4, line 37 - line 38, abstract	1-11
A		12-15
	--	
A	US 5629052 A (PAUL D. TROKHAN ET AL), 13 May 1997 (13.05.97)	1-15
	--	
A	US 5004357 A (HOOYKAAS, CAREL W.J.), 2 April 1991 (02.04.91)	1-15
	--	

INTERNATIONAL SEARCH REPORT

Information on patent family members

02/12/99

International application No.
PCT/FI 00/00110

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0257812 A2	02/03/88	AU 591317 B	30/11/89
		AU 7636087 A	11/02/88
		JP 63043913 A	25/02/88
US 5851598 A	22/12/98	CA 2187055 A	05/04/97
		EP 0838269 A	29/04/98
		US 5876853 A	02/03/99
US 4728530 A	01/03/88	AT 57726 T	15/11/90
		BR 8700089 A	01/12/87
		DE 3600577 A	16/07/87
		EP 0234197 A,B	02/09/87
		SE 0234197 T3	
		JP 62162092 A	17/07/87
US 5629052 A	13/05/97	AU 4903196 A	04/09/96
		BR 9607584 A	07/07/98
		CA 2212175 A	22/08/96
		EP 0809732 A	03/12/97
		JP 11500191 T	06/01/99
		US 5817377 A	06/10/98
		WO 9625555 A	22/08/96
		ZA 9601158 A	30/07/96
US 5004357 A	02/04/91	AT 46943 T	15/10/89
		CN 1005009 B	16/08/89
		EP 0217445 A,B	08/04/87
		SE 0217445 T3	
		JP 62075126 A	07/04/87
		NL 8502650 A	16/04/87
		US 4741629 A	03/05/88